PEARL

The Journal of HEREDITY

SWEET POTATO FLOWERS
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Postponed Genetics Congress Scheduled for 1939
Natural Selection Within a Species
Eugenics at Greenbelt
A Kidney-Inhibiting Gene
Eye-Defects In Guinea Pigs
The Caracul Mouse

VOLUME 28 OCTOBER, 1937 NUMBER 10

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The

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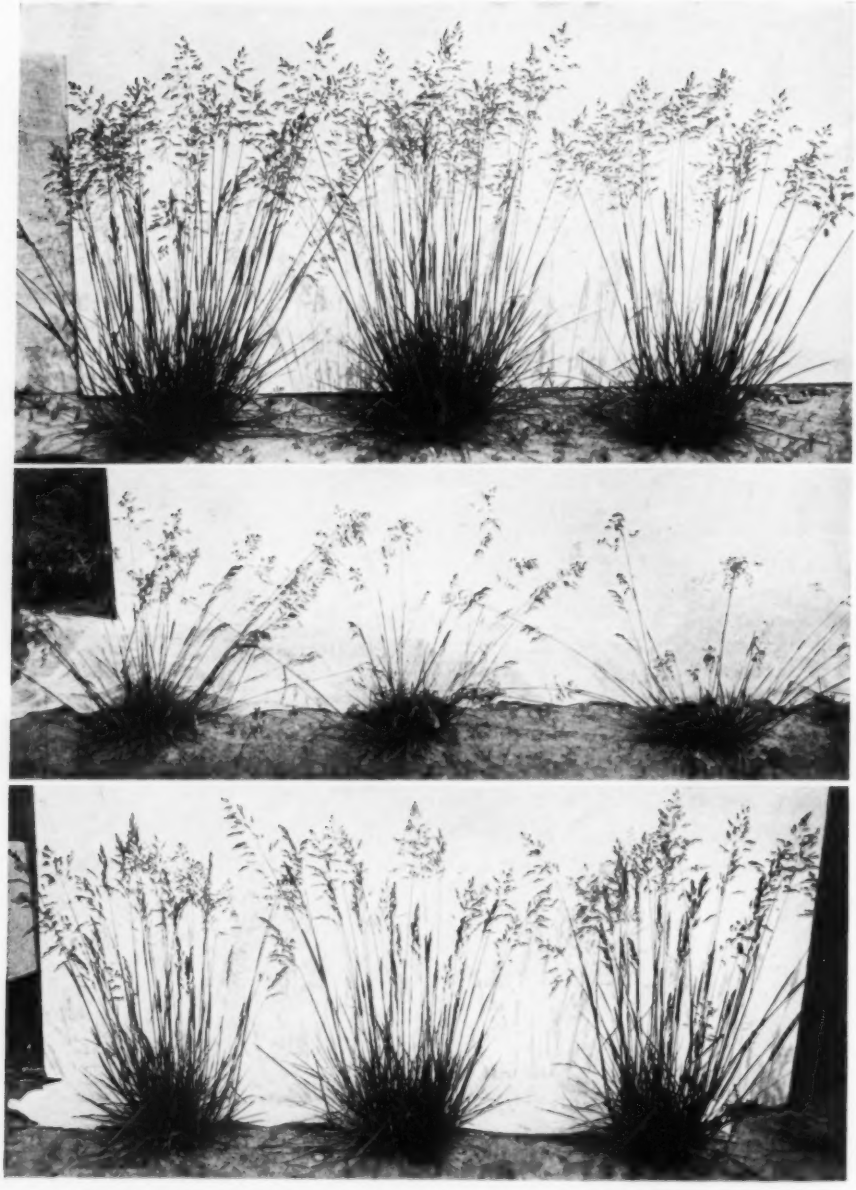
THE SEVENTH INTERNATIONAL CONGRESS OF GENETICS

To Be Held in England, 1939

The question as to the place for the next International Congress of Genetics has now been considered and voted upon by the International Committee of Genetics Congresses. The International Committee has by a large majority resolved to invite the British geneticists to arrange the next congress in Great Britain in 1939. The committee of the British Genetical Society has passed a resolution welcoming the invitation. The British Geneticists will take the earliest opportunity of appointing an Organization Committee which will send out further information concerning the date and place of the congress.

OTTO LOUS MOHR
Chairman of the International Committee



HOW NATURAL SELECTION CHANGES KENTUCKY BLUE GRASS

Frontispiece

The above three photographs show how varying conditions of environment have altered the type of plants which have survived in turf which has not been disturbed for many years. The three seedlings of each strain show how uniform the types are even when reproduction is by seed and not from stolons. The short strains are characteristic of closely grazed pastures, where this growth habit would increase the chances of survival. The tall strains are characteristic of the type found in hayfields, where no grazing had occurred for many years and where short growing forms would be smothered out. Thus in as short a time as 35 years very distinct forms have been evolved by natural selection.

NATURAL SELECTION WITHIN PLANT SPECIES

As Exemplified In a Permanent Pasture

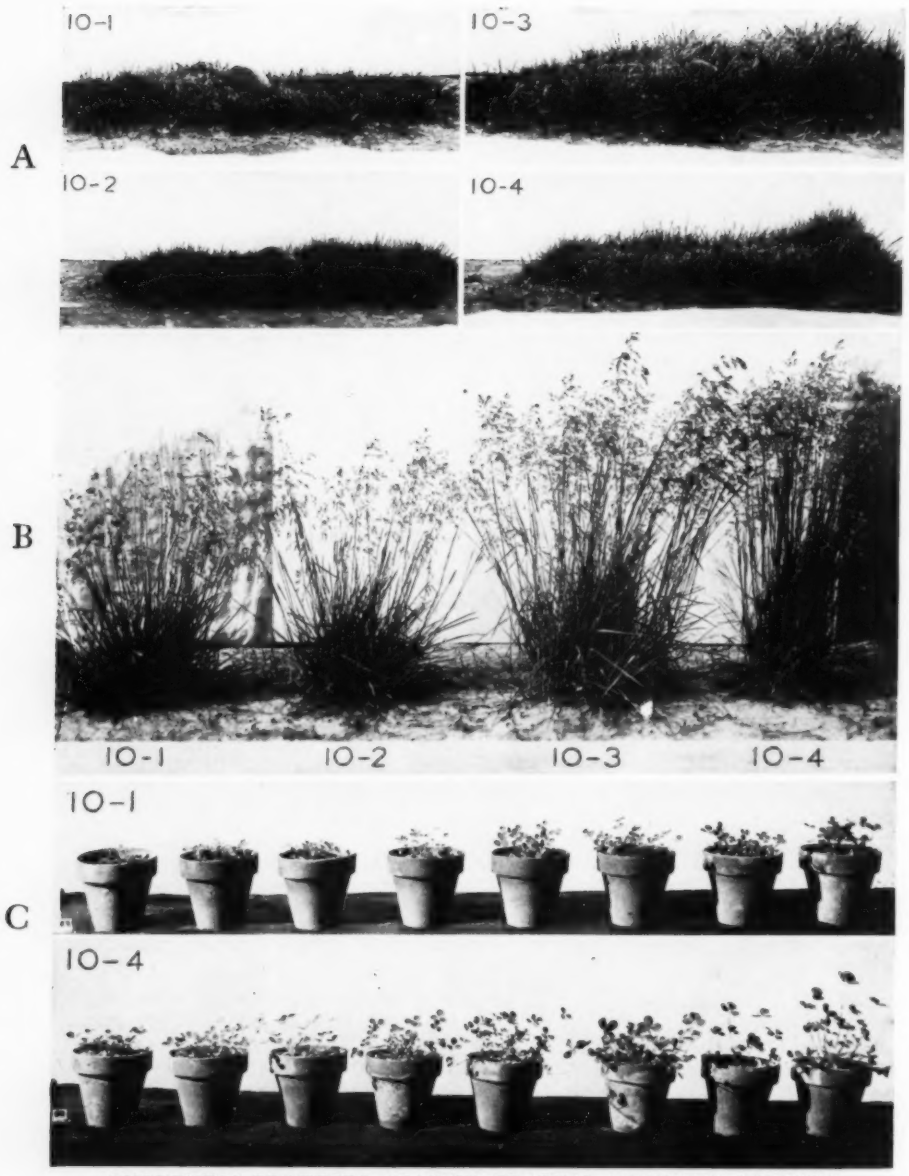
W. B. KEMP
Maryland Agricultural Experiment Station

ALL ARE KENTUCKY BLUE GRASS

Figure 1

Comparable plants propagated from stolons of blue grass growing in permanent turfs exposed to widely differing conditions. Natural selection extending over a number of years has eliminated the forms least able to survive, and has perpetuated a very uniform type (see Frontispiece).

A WISE grower of wheat or corn would not consider seriously the purchase of seed for either of these crops from a region strikingly different in soil or climate from the one in which the crop was to be grown. The varieties or strains in use are adapted to those conditions peculiar to the region. The best wheat variety for Kansas produces a disappointing crop when grown in Maryland. Striking differences in adaptation are clearly recognized for those plant species in which many strains have been isolated. Although selection in grasses has demonstrated also wide differences in vigor and growth habit, yet these demonstrations have exerted relatively little influence upon the commercial seed industry of this country. In general, those strains or genetic mixtures are put on the market, which produce seed most abundantly where seed is grown. Grass seed is purchased without regard either to conditions where it was produced or to use of the resulting crop. This practice prevails to a high degree in spite of the fact that uses to which these plants are put vary as widely as those for almost any other farm crop. Regardless of the territory where wheat is grown, it is used, with only minor



SHORTNESS PROTECTS AGAINST GRAZING, TALLNESS AGAINST SMOTHERING

Figure 2

Nearly a year before the Kentucky blue grass type shown at *A* was photographed (April 19, 1937), the turfs were transplanted from different places on the same farm to a nursery where they were grown under similar conditions. Closely grazed pastures produced turfs 10-1 and 10-2. A hayfield produced 10-3 and 10-4. The seeding stage of these strains is shown at *B*. Stolon propagation from each of these turfs reproduced the distinctive types in every instance.

Clover cultures from the same turfs tell the same story. At *C* are shown clover seedlings from two of these test-plots, 10-1 and 10-4. Here also close grazing has resulted in the survival of a distinct small form, quite distinct from the hayfield type.

TALL PLANTS PROTECT THEMSELVES BY LYING DOWN

Figure 3

The orchard grass on the left was taken the previous year from a closely grazed pasture. That on the right was taken from a hayfield. The upper picture shows the procumbent growth habit of the pasture strain during the vegetative stage. At flowering time (below) the procumbent stems of the pasture strain grow upright for seed production.

exceptions, for production of grain. On the other hand some of the grasses may be used for hay, for pasture, or for lawn. Some permanent pastures are fertilized, limed, and grazed judiciously. Others receive no soil amendments and the plants are closely grazed during both winter and summer. However, some of these permanent pasture plants manifest a remarkable capacity to persist under the widely varied conditions which obtain in different pastures. A close study of the plants from different permanent pastures shows some of the results of natural selection as it has brought into ascendency those types of a species which are best adapted to survive grazing conditions of the particular pasture.

ORCHARD GRASS ALSO AVOIDS GRAZING BY DWARF GROWTH

Figure 4

While some strains of orchard grass survive close grazing by growing close to the ground (Figure 3) the same species may produce strains which meet similar conditions by producing very short flowering stems.

Tests of Old Turfs

Casual observations tending to confirm this rôle of natural selection have extended over a number of years. However, in the spring of 1936 an opportunity was presented for a somewhat more detailed study. At that time areas of turfs of four square feet each were moved from various permanent pastures to the Agricultural Experiment Station farm at College Park and set in a relatively uniform soil. The pastures in which these turfs grew were selected in different parts of the State on different soil types with different levels of fertility and acidity. Wherever a turf was chosen a soil sample was taken also. No pasture was selected for sampling unless all available information indicated that either no seed of permanent pasture plants had been used for at least 35 years, or the pasture had been established without use of seed.

After stolons of Kentucky blue grass (*Poa pratensis*) from many of these different turfs had spread to the local uniform soil and had taken root, samples of these stolons were moved so that the resulting plants might be compared without association with soil of the original turf. Some of the

orchard grass (*Dactylis glomerata*) and white clover plants (*Trifolium repens*) that were present in these turfs were moved also in order that they might be compared with plants from ungrazed areas. Figure 1 shows some of the genetic variability among these Kentucky blue grasses.

In the summer of 1936, seed of blue grass and of white clover was saved from a number of these turfs. In the fall of the same year this blue grass seed was planted in separate plots. A part of each plot was seeded thick and a part was set to individual plants so spaced that each plant could be observed separately. The white clover seed was planted in flats in the greenhouse in late winter and individual plants were later transferred to pots where they were permitted to grow until they were ready for setting in the field in the spring of 1937. Accompanying photographs (Frontispiece) show the genetic uniformity which obtains among progeny from seed of any one strain of Kentucky blue grass. The same uniformity obtains in depth of color and in disease resistance that is so evident for growth habit.

One of the most interesting series of turfs in the entire lot was obtained from a single farm in southern Maryland in a section where very little blue grass grows and very few permanent pastures are established. There is no record of the purchase of any Kentucky blue grass or white clover for this farm at any time. Certainly none has been seeded during the past thirty years. That which is present in permanent pasture has gradually occupied the land while it has been grazed during winter and summer as close to the ground as horses and cattle are able to graze. On the same farm is another area that was once seeded to alfalfa. During the succeeding years this alfalfa was gradually replaced by blue grass. Since the area is irregular in shape and troublesome to cultivate, it has been used for production of hay and intermittent grazing.

During approximately the same period of time in these two fields blue grass has gradually occupied the land. However, in one field the surviving plants are those which can withstand constant close grazing, while in the other the surviving plants are those which can compete on land devoted to hay and intermittent grazing. Those insignificant differences in soil fertility and acidity which exist are in favor of the constantly grazed land.

Accompanying photographs (Figure 2*A*), taken April first, 1937, show the contrast in growth on turfs from these two areas nearly a year after they had been moved to their new location. It will be noted that in each case growth is much shorter on turfs from closely grazed land than it is on the others. As evidence that this difference in growth is a result of differences in genetic constitution of the grasses, another photograph shows flowering plants side by side from stolons taken, two from these grazed turfs and two from the hay turfs. The same differences in size that are manifest in early growth carry through the heading stage. Those blue grasses which have occupied the ground where constant grazing has been practiced for many years are of genetic types distinctly smaller than those from lightly grazed or hay land.

White Clover

Most of the turfs that were brought in contained some white clover. The white clovers which had been isolated from the turfs repeat, in their size differences, the same response as that which is apparent in the Kentucky blue grasses. While progeny from seed of the different clovers is not nearly so uniform in either size or growth habit as progeny from the blue grasses, yet on the average those from closely grazed turfs are much smaller than those from sparsely grazed ones. Figure 2*C* shows seedlings before they were set in the field.

For the past 25 years, to the writer's knowledge, those balks between plots on the Station farm that have been mowed only occasionally with a field mower have contained white clovers at least as large as Ladino, the big

white clover from Switzerland. These "native" white clovers withstand the summer weather somewhat better than Ladino. However, unlike Ladino, they do not breed true from seed. Some of the progeny are as big as the ovule parent. Others show gradations in size. Some plants are as small as seedlings from normally pastured land. Perhaps small clovers are always close at hand for cross fertilization.

No orchard grass plants were found in the turfs from the southern Maryland farm. However, a pasture in Baltimore County contains many scattered plants of this species which appear to have survived some years of close grazing. An examination of these plants after isolation shows that all have one characteristic in common. Each bud, no matter where it may be located in the tuft, tends to grow horizonally for a short distance before it turns upward to permit the production of an erect seed stalk. Apparently these procumbent buds escape the teeth of grazing animals and only blades are consumed from the basal growth. In contrast to this growth habit, most of the orchard grass plants that are observed show all buds erect except those around the edge of the tuft which are forced outward by the growth of those at the center. Figure 3 shows two photographs which were taken at different stages of growth of the same two orchard grass plants. The plant at the left was taken from this closely grazed pasture. The one at the right was taken from the edge of a hayfield. These plants were first photographed before the pastured plant had assumed an erect position. They were later photographed after heads had formed. At that time the plants were hardly distinguishable as to type.

Another growth habit by which some plants of orchard grass apparently survive close grazing is shown in Figure 4. The plant shown here is small, not clearly tufted, and all buds, while erect, put out blades close to the ground until the seed stalks finally elongate.

These manifestations of differences in growth of blue grass, white clover, and orchard grass associated with differences in grazing, indicate that a high degree of natural selection within each species operates in the permanent pasture. Apparently strains can be isolated that are capable of surviving under the closest grazing that horses or cattle can give. It remains to be discovered whether such strains are capable of sufficient yield to justify their isolation and use. Perhaps it will be found that an old pasture which has been mistreated for many years, even though the stand of plants may be satisfactory, can be returned to profitable production only by plowing and reseeding to strains of satisfactory genetic type. On the other hand, it may be that a permanent pasture of some plants can be maintained in satisfactory conditions under close grazing, only if it is seeded to genetic types whose growth habit is adapted to such closely grazed pastures.

◆

A NEW MUTATION IN THE HOUSE MOUSE

THIS mutation consisted of a single male mouse, one of a litter of seven, which was first noticed on January 11, 1937, when the animal was about fourteen days old. It occurred in our breeding colony of two thousand albino "Swiss" mice, the foundation stock of which we had received from Doctor Leslie T. Webster of the Rockefeller Institute of New York.

Because of the peculiar character of the coat, this mouse has been referred to as the "Caracul" mouse. On February 8th the mouse was placed with three females chosen at random from the colony. Three litters have been born as follows:

5 normal coat	3♀♀	2♂♂
4 Caracul "	1♀	3♂♂
2 normal coat	1♀	1♂
2 Caracul "	1♀	1♂
3 normal coat	1♀	2♂♂
3 Caracul "	3♀♀	0♂♂

This character is distinguishable from the time that the whiskers and body hair are visible. The body hair lies in fluffy waves, which make the mouse look much broader than the normal mouse, and the vibrissae are markedly curved. In the fourth week the body hair begins to straighten and the wave gradually disappears. The adult except for a distinctly plush-like appearance looks grossly like a normal mouse. If one looks at the adult from the side, nowever, it will be seen that the guard hairs are recurved towards the head at their tips and the whiskers are still curved. The coat, when stroked the wrong way, does not fly back as does the normal coat. One litter has been turned over to Doctor L. C. Dunn for further investigation.

F. G. Carnochan

Carworth Farms,
New York City, N. Y.

CARACUL A DOMINANT MUTATION

FURTHER experiments have shown that Caracul is dominant, viable in the homozygous condition, and easily distinguished shortly after birth. It should thus prove to be a very useful character for linkage and similar experiments.

The breeding data obtained to date are shown in Table I. The F_2 ratio leaves little doubt that Caracul segregates in a 3:1 rather than in a 2:1 ratio. The viability of the Caracul homozygote is further proved by progeny tests of F_2 Caraculs. Of three such males tested by normal females, two have given both Caracul and normal young while one has given 42 offspring, all Caracul. Of four F_2 Caracul females tested by normal male, two have given both Caracul and normal, while two have given only Caracul, 11 and 16 in number. No relation of the new mutant to sex has been observed.

We find that, in segregating litters, Caraculs and normals can be accurately classified on the day after birth. The vibrissae in Caracul are curved and of irregular direction; in the normal they are straight and parallel. The waving of the hair in the first pelage seems to be more marked than in either of the two previously reported recessive waved mutations (Crew*; Keeler†).

We have not noticed any difference between homozygous and heterozygous Caraculs. This full dominance is in evidence in out-crosses of Caracul to four different laboratory stocks. This is interesting as evidence that a new mutation may show marked dominance in various genetic backgrounds at its first appearance.

Breeding material of the new mutant may be obtained from Carworth Farms, New York City, N. Y.

L. C. Dunn

Columbia University,
New York City

TABLE I. Results of matings involving Caracul mutant and its descendants.

Parents	Observer	Offspring		Litter size
		Caracul	Normal	
Caracul mutant × normal	Carnochan	45	40	7.7
F_1 Caracul × F_1 Caracul	Carnochan	41	12	7.6
F_1 Caracul × F_1 Caracul	Dunn	100	30	8.4
Total F_2		141	42	
F_1 normal × F_1 normal	Carnochan		35	8.7
F_1 Caracul × normal	Dunn	14	19	6.6
F_2 Caracul (♂#7) × normal	Dunn	42		7.5
F_2 Caracul (♀#9) × normal	Dunn	11		5.5
F_2 Caracul (♀#8) × normal		16		8.0

*Crew, F. A. E. Waved: an autosomal recessive coat form character in the mouse. *Jour. Genet.* 27:95-96. 1933.

†Keeler, C. E. A second rexoid coat character in the mouse. *Jour. Hered.* 26:189-191. 1935.

AN INHERITED KIDNEY ABNORMALITY IN THE DOMESTIC FOWL*

F. P. JEFFREY, F. R. BEAUDETTE, AND C. B. HUDSON

New Jersey Agricultural Experiment Station, New Brunswick, N. J.

A KIDNEY abnormality in which the left kidney is either atrophied or completely missing has been observed in the strain of Single Comb White Leghorns maintained by the Poultry Department of the New Jersey Agricultural Experiment Station. Fourteen cases have been observed in four generations. The abnormality has appeared only in females and without exception the left kidney has been the one which was either atrophied or absent.

In observations on one thousand avian autopsies Carpenter[1] has reported a single case of compensatory hypertrophy where there was no trace of the left kidney. He did not indicate the sex of the bird. Because more than 99 per cent of his autopsies were performed on White Leghorns it is probable that this case was found in that breed. Roberts, Card and Boyden[2] reported three females with double vents associated with congenital absence of the left kidney. Reis and Nobrega[3] have cited Zurm[4] and Bauman[5] as reporting cases of complete absence of one of the kidneys. These two latter references were not available in original form and no conclusions can be drawn as to breed and sex nor regarding which kidney was absent.

The pedigree reproduced in Figure 6 includes only those birds which were autopsied in the laboratory. In most instances the sex of birds which died before reaching 20 weeks of age was not recorded. Cases where the sex was not known have been represented in the pedigree by means of a question mark (?). No cases of atrophy of the left kidney were observed in the group of birds of unknown sex. Eleven of the fourteen abnormal cases have been indicated in the pedigree. Of the remaining three, one was not shown because it came from a group of unpedigreed eggs and the other two were not shown because they arose in the fourth generation. At the present writing 80 per cent of the fourth generation females are still alive and it was felt that it would be misleading to include fragmentary families.

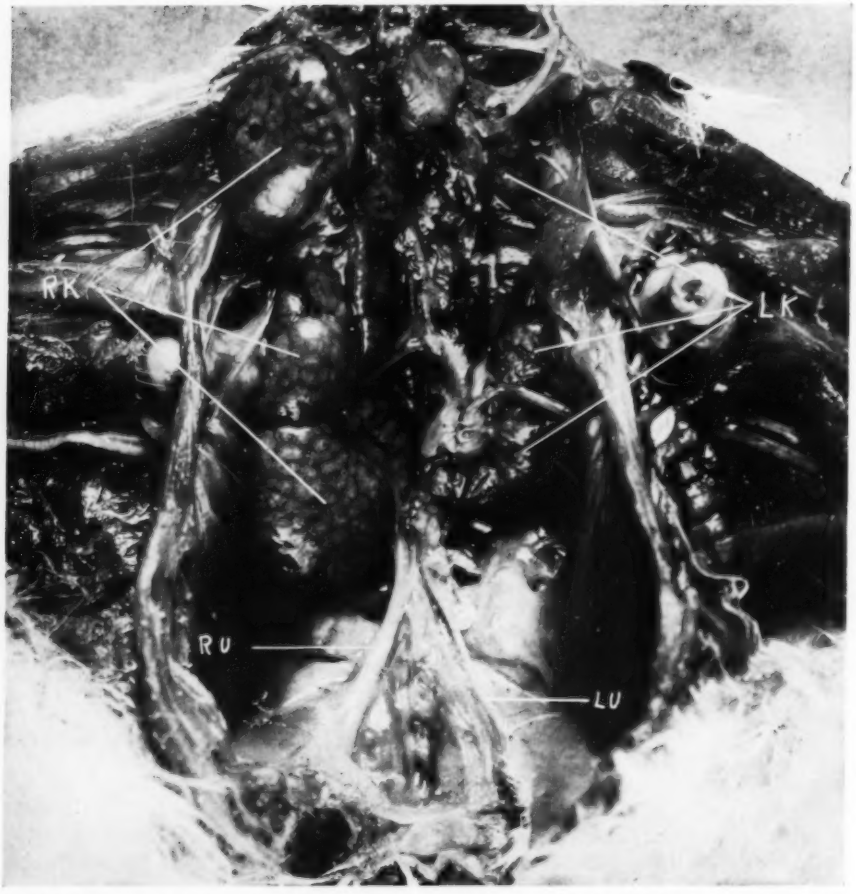
Atrophy of the right kidney has been observed recently in a Barred Plymouth Rock female sent in to this laboratory from the field. It was impossible to determine whether this case might be due to heredity because the bird was not pedigreed.

Stock

In 1932 hatching eggs were purchased from twelve independent sources for study on the inheritance of resistance to fowl paralysis. Two of the twelve lines thus established, namely, the *OR* and *BL* lines, proved to be of most interest for this report. One female, *A 483* (*BL* line), was the only bird showing atrophy of the left kidney in the original stock. Because *A 483* was not bred and because the original hatching eggs were not pedigreed this case is not shown on the pedigree in Figure 6. It is significant to note, however, that this bird came from the same source as females *A 514* and *A 559* and male *A 923*.

In 1933 all lines were inbred and three abnormalities appeared in two lines. In the *BL* line female *A 514* mated to *A 923* produced one affected

*Journal series paper, N. J. Agricultural Experiment Station, Department of Poultry Husbandry.



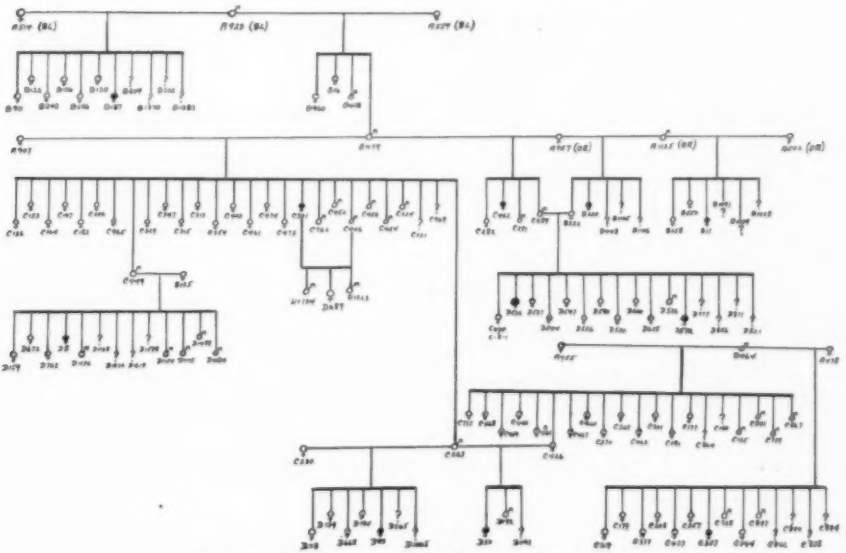
ATROPHY OF THE LEFT KIDNEY IN A SINGLE COMB WHITE LEGHORN

Figure 5

A photograph of the abnormality in female *E 160*. The three lobes of the right kidney (*RK*) and the right ureter (*RU*) show hypertrophy while the lobes of the left kidney (*LK*) are atrophied and the left ureter (*LU*) is normal in size.

to five normal daughters and four normal birds of unknown sex. In the *OR* line male *A 1125* mated to *A 757* and *A 502* gave two affected to three normal daughters and five normal birds of unknown sex.

In 1934 breeding within the lines was discontinued and again three abnormalities were observed. Male *B 439* of the *BL* line mated to *A 757* of the *OR* line and an unrelated female (*A 907*) sired two affected and seventeen normal daughters, nine normal sons and two normal birds of unknown sex. The third case arose independently from a mating of unrelated stock (*B 464* × *A 478*). This is the only case which cannot be traced to either of two males, namely, *A 923* and *A 1125*.



PEDIGREE OF A KIDNEY ABNORMALITY

Figure 6

Pedigrees of eleven affected females discussed in the article. Ten of the eleven cases trace their ancestry to male *A 923* or male *A 1125*.

Five abnormalities were found in the birds hatched in 1935. Male *C 289* mated to *B 232* gave two affected and nine normal daughters, one normal son and four normal birds of unknown sex. Male *C 223* mated to *C 230* and *C 426* sired two affected to four normal daughters, one normal son and three normal birds of unknown sex. Male *C 449*, a full brother of *C 223*, mated to *B 125* produced one affected to three normal daughters, five normal sons and four normal birds of unknown sex.

Two abnormalities have been observed in the progeny of birds mated in 1936 and as explained previously these cases have not been shown in Figure 6. *D 689* (a son of *C 289*) mated to *D 108* (a daughter of *C 223*) sired affected female *E 118*. *D 803* (a son of *C 289*) mated to his half sister, *D 698*, produced affected female *E 160*.

Observations

The abnormality as found in female *E 160* is illustrated in Figure 5. The left kidney (*LK*) is atrophied and the left ureter (*LU*) is normal in size. Both the right kidney (*RK*) and right ureter (*RU*) show compensatory hypertrophy. No photograph is available to illustrate complete absence of the left kidney although it was observed that the left ureter was still present in those cases. All fourteen cases were marked by compensatory hypertrophy of the right kidney.

Discussion

The best evidence to show that this abnormality is inherited is that twelve of the thirteen cases which have appeared in pedigreed stock trace back to either of two males, *A 923* and *A 1125*. At the present time about 50 per cent of the experiment station flock show either one or both of these males in their pedigree. A study of the pedigree reveals that the ratio of affected to normal females varies widely in different families. A ratio of one affected to 16 normal occurred in

the female offspring of *A 907* × *B 439*. Such a wide deviation from a 1:3 ratio would seem to invalidate a single gene hypothesis. It is possible that the gene affecting this abnormality can act only in combination with another gene or genes.

On strictly theoretical grounds the possibility arises that we may have here a gene increasing "the range of effectiveness" of a basic gonad-limiting gene conditioning the development of another part of the genito-urinary system—the adult female fowl normally having only a functional left ovary and oviduct. In the embryo the right ovary and oviduct also develop, but as development proceeds degeneration sets in and at hatching time only rudiments remain. The editor of the JOURNAL has pointed out that in maize there is a rather complete range of "sex altering" genes including "male sterile" and "female sterile" and a whole series of intermediate forms. We might speculate on whether our abnormal kidney strain may be of a similar nature. The fact that the left kidney is atrophic, whereas the *right* ovary and oviduct are normally inhibited from development, is certainly an embarrassment to the plausibility of this speculation. The usefulness of such a gene in the "genetics and development field" is evident. The above speculations must remain as such until we have inbred the affected stock more intensely with the hope of obtaining more precise knowledge about the genetic basis of this character.

The mean length of life of the affected females was 490 days with a range from 196 days (*B 187*) to 605 days (*D 93*). Excepting *B 187* all birds produced some eggs and *D 572* had a first year's egg production of 226. These observations indicate that absence of the left kidney has not reduced length of life or fecundity to any marked extent.

Three of the affected birds have been used as breeders. All the female offspring of affected females *D 536* and *D 572* are still alive. Affected female *C 301* mated to a full brother *C 446* produced but three offspring, two males and one female, and all were normal.

The ratio of females to males in the pedigree is 87 to 29. The reason for such an aberrant sex ratio is that the expense of rearing all male chicks is considerable with the result that a large number of them are sold as broilers when they are ten to twelve weeks of age. The sex ratio of 3 females to 1 male as found in the pedigree is representative of the population from which it was drawn. The total number of autopsy records available for this study, excluding partial records on birds hatched in 1936, was 3,639. Of these 1,642 were females, 507 males and 1,490 not identified as to sex.

Since twelve cases of atrophy of the left kidney were found among the 3,639 autopsies and all were definitely identified as females there is the possibility that this abnormality is sex limited. In view, however, of the abnormal sex ratio of the samples for the reason above noted, no definite conclusion can be drawn as to this possibility.

Summary

An inherited kidney abnormality in the White Leghorn breed of the domestic fowl was described. Data were insufficient to determine the mode of inheritance. The possibility that this abnormality might be limited to the female sex was pointed out but preponderance of females in the pedigree made it impossible to draw a definite conclusion.

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EUGENICS AT GREENBELT

GREENBELT VISTA

Figure 7

A corner of Greenbelt, showing the type of structure in the model housing project of the U. S. Resettlement Administration. The first group of 855 housing units have recently been opened for occupancy.

THE opening for occupancy of the model Federal Housing project at Greenbelt, seven miles from Washington, D. C., has considerable interest for students of eugenics. Since its inception, the New Deal has made a variety of efforts to house the "forgotten man." Subsistence homesteads held the stage for a while, and several other projects under various agencies have had their day. These activities have gradually been modified and combined, until at present they are mainly centered in the Resettlement Administration of the U. S. Department of Agriculture.

While no claim whatever is made by the Resettlement authorities that Greenbelt and similar model housing projects are in any sense eugenic experiments, the fact remains that they can hardly be entirely devoid of eugenic implications. The people who are being chosen as "Greenbelters" represent a hand picked group from the lower economic brackets. They are being selected as carefully as possible for certain characteristics of social value, such as cooperative interest, economic worth, and other less tangible attributes of personality. In these communities the environments in which they live is being created and controlled to an extent unprecedented in America. The way in which this is done, and the effect it has on increasing or decreasing the birthrate of the selected group, are matters which every eugenist must view with absorbed interest.

The Resettlement Administration has not issued in detail the selective technique used in choosing the Greenbelt colony, but from the information service of the U. S. Department of Agriculture, from announcements in the press and through some of the publications of the Administration as well as by personal interviews, the following information has been gleaned about the new "Settlers" in Greenbelt and the administration of the project.

Basis of Selection

Applicants are carefully investigated independently by at least three investigators, whose procedure is based on a modification and adaptation of the family selection techniques set forth in a

recently issued analysis of selective methods.* The procedure used for Greenbelt is about as follows: "Interested applicants file an application form, which is checked by the financial expert." "One or two-person families with an income of less than $1,000 will be considered. Also families of five or six persons with an income up to $2,200 will be thought eligible." "And in the case of Greenbelt seven families with an income as high as $2,299 have been admitted."

If the applicant's income is satisfactory an appointment is made and he is taken out personally to visit the Greenbelt project. During this visit the representative of the project explains the social and health advantages of residence there, and the applicant is judged on personality, intelligence, and cooperative spirit. If the applicant still desires to become a "Greenbelter," and if he has passed the informal "onceover" on the part of Greenbelt representative he is sent a more detailed questionnaire and visited at home by a social worker. All members of the family are interviewed and the neighborhood in which they live is evaluated. The applicant is then judged in relation to his financial "congruity" with respect to his environment. That is, if his financial standing appears to be higher than the neighborhood in which he lives, it is held to show that he tends to be of slovenly and unprogressive habits and might therefore be undesirable. If, on the other hand, he is living in a neighborhood too expensive for his income, he is considered to be socially maladjusted and this is a point in his favor, because it appears that he has not succeeded in finding a home suitable to his financial needs. After the applicant has passed the home and neighborhood examination his previous history as a tenant is carefully investigated. Careful inquiry is made as to the care he has taken of the premises on which he has lived, and the promptness with which he has met payments of rent. Furthermore, his economic situation is investigated (debts, etc.) and he is questioned as to what plans he has made for meeting his financial obligations. These points are considered of great importance in arriving at an evaluation of the applicant.

The Greenbelt Colony

The Greenbelt project is described as follows in a Press announcement of the Resettlement Administration:

Rentals for the modern, carefully designed dwelling units in the new community are based on an average charge of $5.90 per room per month, without heat and utilities. The rents stipulated in the tenants' leases, however, will include the heating of their dwellings and the heating of water. Electricity and water consumption will be billed separately on the basis of the amounts used.

The rentals will range from $18.00 to $41.00 per month with an average rental per dwelling-unit of $31.23, including the heating both of the dwelling and of water. It is estimated that the average family will pay $1.21 per month for water and $3.18 per month for electricity which will be used for cooking purposes as well as for lighting and refrigeration. The rents of the homes designed for larger families have been somewhat less per room than the smaller dwellings. * * * While these dwellings are simple in design they will be equipped with electric stoves for cooking, electric refrigerators and modern kitchen cabinets.

There are 574 units in group houses, all but sixteen of which are two story dwellings. The rental for the two story dwellings, including heat, will run from $29.00 per month for four-room houses up to $39.00 per month for seven-room houses, with a few units in the most desirable locations running up to $41.00 per month.

Five detached houses of prefabricated design are included in the community and will rent for slightly more than the group houses.

The remaining 306 dwelling units are in apartments. The rents charged for these units will include janitor service as well as the heating of the apartments and water. Apartment rentals will run from $18.00 for one and one-half room dwellings to $27.00 per month for three-room apartments, and to $32.00 per month for dwellings consisting of three rooms and sleeping porch.

Income Limitations

In order to assure that the opportunities afforded by residence at Greenbelt go to the

*Holt, John B. An Analysis of Methods and Criteria Used in Selecting Families for Colonization Projects. Pp. 54. Mimeographed. U. S. Dept. Agr. *Social Research Rept. No. 1.* Washington, 1937.

families who need these benefits, occupancy will be restricted to families with low incomes. Residents of Greenbelt will be selected from applicants whose incomes range from $1,000 per year to $2,000 per year, as was announced at the time the project was undertaken. In special cases, individuals with annual incomes of less than $1,000 may be accepted. Consideration will also be given to families with three children whose incomes run as high as $2,100 per year, and up to $2,200 for families with four children.

Within these limits, the maximum income of families to be accepted for the various units will be related to the rents of the dwellings, so that the least expensive units will be reserved for families with the lowest incomes. No families will be accepted who would be ineligible under the income limitations prescribed in the recently enacted Wagner-Steagall Housing Act.

Recreation, Schools, Utilities

Greenbelt is a completely planned town surrounded by a green belt of woods and farm land protecting it from undesirable encroachments. On the borders of the town is an artificially created lake of 25 acres available for boating and swimming, and a large recreation center with athletic fields, playgrounds, picnic areas. A system of trails and camp sites is planned to make the woods and forests accessible for hiking and other outdoor sports. * * *

There are two new schools—a high school which will be shared by other residents of the County, and a grade school which will also serve as a center of the community life. Here will be found the town library and the community auditorium and gymnasium, capable of seating 800 persons.

Greenbelt has a complete new system of roads and utilities. Six miles of hard surfaced roads and eighteen miles of walks have been constructed. The sewerage system comprises a new disposal plant, sixteen miles of storm sewers and ten miles of sanitary sewers. Four miles of new water mains, five miles of service connection lines and a new water tower, with a capacity of 2,000,000 gallons have been installed. A complete new electrical distribution system has also been built. All of these utilities have been designed and built to take care of the expected growth of the town. They will be able to serve a total of 3,000 houses or a town nearly four times the size of the present one.

Consumers' Cooperative is to be given a unique opportunity to prove its worth here in this model community:

The town has a planned business center, easily accessible to all dwellings. The commercial center, which will provide for all the town's usual needs, contains a food store, a drug store, a general merchandise store, a restaurant, a barber shop and beauty parlor, a service garage, bus station and filling station, a laundry agency, a motion picture theatre, a post office, offices for doctors, dentists and other professional persons, and Administration offices.

To secure the most economical operation for a town of this size only one shop of each kind has been included in the commercial center. It is essential therefore, that precautions be taken to avoid any possibility of monopolistic abuse, and assure commercial services satisfactory to the tenants.

Since the stores must be in operation as soon as tenants move in, an interim arrangement for operation of the stores has been found necessary. A lease agreement has, therefore, just been entered into for this service with the Consumer Distribution Corporation, a non-profit organization founded by Edward A. Filene, of Boston.

This agreement completely safeguards the interests of the Government and the residents of the community. No profits will be retained by the Corporation, but will accrue to the benefit of the inhabitants of the town. The agreement stipulates that the commercial enterprises may be turned over to cooperatives organized by the residents if they desire to accept this responsibility. *The tenants themselves under the terms of the lease will eventually determine how the stores and the facilities will be operated.* The Consumer Distribution Corporation has nothing whatsoever to do with the operation and management of the residential properties or with the administration of the town.

The Corporation and any cooperatives to which the stores may be turned over will pay normal rents for the commercial properties. The rents will be a percentage of the gross sales of the various businesses. These percentage rates are those which are usual in private enterprises of the same nature.

Status of Settlers

On September 23, out of the 3,982 families who had filed applications for Greenbelt, 2,416 or approximately 60 per cent, were found eligible after the exhaustive questioning of the various workers. Of this number only seven had incomes of above $3,000 while 20 were below $1,000, and the modal income ranged between $1,200 and $1,900. The youth of heads of families was also significant, the majority being between 21 and 29, although there were thirteen under 21 and thirty-one who were over 60.

The following table from the same report regarding the employment status of future Greenbelt inhabitants will catch the tax-payer's eye:

Government	1,781
Private	635

Can it be that this is to be in truth a government housing project, instead of a slum clearance project—as it was originally designed to be?

Another interesting bit of information brought out in the above-mentioned report is the *size of the families* of those applying for housing and found eligible: 828 families have only one child while there are but 123 families with four children—and 43 one-person "families."

For those people interested in the future of the American race, this is likely to be a disturbing thought. Realizing the extreme care with which the government has sifted out the applicants in order to furnish housing only to those most "eligible," does this mean that the most worth-while of our American families in the wage brackets from $1,000 to $2,000—those commonly referred to as the "Backbone of our Nation" — are either childless or are bringing up but one or two children? If so, who are to be the parents and what is to be the background of the next generation in our country? Has the government put a premium on small families amongst the highest type individuals in the lowest income group, by limiting the size of the families admissible to Greenbelt and similar developments where the environment would be the most advantageous to children? Since the Community is to be made up largely of government employees, there may be some comfort in the thought that Greenbelt may unexpectedly result in keeping small-time bureaucracy from becoming hereditary in this country.

Theoretically eugenics was to have been one of the angles of approach in selecting families for these governmental housing projects, to judge by a statement in The Analysis of Methods booklet:

"Have the recommending workers re-investigate each remaining family with respect to:

(b) Psychological, moral, hereditary, and physical factors required for a healthy family.

So far as we are able to find, however, no actual eugenical investigation has been made of the Greenbelt "Settlers." Possibly that will be the basis for the further selection necessary to pick the comparatively few families who will actually live in this particular paradise; for obviously a further sifting out must be made when one notices that 2,416 families had been accepted as eligible to occupy the 855 homes said to be available.

Eugenic Implications

The eugenic implications of the Greenbelt experiment are interesting to speculate upon. That rather stringent selection has been practiced for certain qualities is obvious. Whether the technique has separated a group more eugenically desirable than the class from which it is drawn might be a matter of opinion, but we can hardly question that a group rather more than averagely intelligent, cooperative, and financially responsible has been picked. The question of what effect the Greenbelt plan actually will have in altering the size of family in this group is of prime eugenic importance.

In this connection Julian Huxley's 1936 Galton Lecture (Abstracted in the JOURNAL OF HEREDITY for August, 1936) makes most interesting reading. Huxley's main thesis was that environment is a matter of basic importance in eugenic planning:—"Selection is theoretically meaningless and practically without value except in relation to a particular environment." "Even if we take the environment for granted, we must face the fact of social change and attempt to meet it eugenically and in so doing we shall find it difficult to avoid giving some play to our wishes, fears, and hopes." The converse of this, which perhaps we see at Greenbelt, is also true, namely: That whenever we take heredity for granted in our attempts to control social change we almost certainly affect the genetic constitution of future generations whether we admit it or not. As Lord Horder has so aptly pointed out: "If heredity does not work for us it works against us." It works against us in a number of ways. To quote Huxley again: "Not only this, but we know from various sources that raising the standard of life among the poorest classes almost invariably results in a lowering of their fertility. In so far, therefore,

as differential classifications exist, raising the environment level will reduce many dysgenic effects which it may now have." This would be true, of course, if the environment of a whole class of the population were raised, but in this instance, we are carefully selecting a group which shows certain socially desirable traits. The implication that their fertility would be reduced merely by transplanting to the Grenebelt environment is so strong as to amount almost to a conviction in the light of other tendencies.

Size of Family

There are other forces of a less intangible nature, acting in the same direction. It has been reported in the press that a definite policy of child limitation has been embarked on by the Resettlement authorities. The reason for this is the very small size of the Greenbelt units. A majority of them are designed only for families in which there are three members. A few of the units are capable of housing a family of six (that is, a four-child family). The same report states that the lease specifies that there are to be no additions to the family for the first year, and that families of over four children must count themselves out as Greenbelt residents. The eugenic implications of this situation are most interesting in view of the recent statement in the Program of the American Eugenics Society: "To bring the average up to three, and to secure permanent replacement for any population group, a fairly large proportion, about 20 per cent, must have five or more children." Thus by the very terms of the Greenbelt situation this selected group appears to be absolutely prevented from furnishing a replacement quota of children to the next generation. That the Greenbelt project could have any positive eugenic effects would seem in view of this situation to be very problematical indeed. To quote Huxley again: "We eugenists must no longer think of the social environment only in its possible dysgenic or non-eugenic effects, but must study it as an indispensible ally. Changes in social environment are needed both for the adequate expression of eugenic progress, and a means for its realization." The projection of this viewpoint onto the actual situation at Greenbelt shows how urgent is the need for eugenic thinking in developing a resettlement and conservation project. In these projects human selection is actually being carried on, probably not perfectly, but with a fairly well defined technique. If we assume that this selection gives us anything but a random distribution of the group selected from, it is of immediate eugenic importance to discover whether our group is of greater or less eugenic worth than the population from which the group was selected. If we decide that our selection has brought together a group of people of doubtful value as parents of future generations, then the environment of Greenbelt will probably be adequate to prevent the multiplication of the group we have assembled.

If, on the other hand, we have reason to believe that we have selected a better than average group, biologically speaking, then it follows almost as an axiom that the planning of the units at Greenbelt and the policy of restricting family size there adopted, represents a very dangerous dysgenic tendency. Only a small part of the Greenbelt project has been completed, and possibly additional units will be added later. If this should ever be done, it would seem urgently necessary on eugenic grounds that the added units should be of larger size so that families which exceed present accommodations could be cared for in the community, without throwing them back into the outer world of residential pot-luck, just when they most need the Eden of a resettlement colony. Further than this, we must remember that in the income group from which the Greenbelt colonists are drawn, there must be a considerable number of better than average families which have three or more children. The children in these families, who need especially the social and economic advantages of Greenbelt, have no chance at present to be taken into the colony.

Other aspects of the Greenbelt experiment also have interesting eugenic implications. The statistics on marital condition of the group accepted for Greenbelt residence is divided into three categories:

Single	124
Married	2,109
Other	173

Inquiry of the Resettlement Administration indicates that the "other" group is made up of widowed and divorced persons. The statistical evidence of the relative infertility at divorcees, and the conceivably adverse effect of this group, as a statistical entity, on family size at Greenbelt, might have an adverse eugenic effect. Conceivably also, it will have an influence in strengthening the group mores to favor a small number of children. If it actually is the policy of the Greenbelt authorities to limit family size as drastically as possible, the inclusion of this group may represent a sound statesmanship—if the basic premise is granted. If it is not, then this may be a further instance of the unfortunate eugenic outcome of policies initiated without sufficient thought as to the biological realities of the situation.

It may be worthwhile to note at this time that the report on "Analysis of Methods Used in Selecting Families on Colonization Projects," which is said to be used as a guide in the Greenbelt selection, is in itself a document of considerable eugenic interest. It abstracts and evaluates all selective methods used on resettlement and reclamation projects in the United Statse. To do it justice would exceed the available space, but it is hoped that a discussion of it at length can be included in an early issue of the JOURNAL.

—R. C.

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THE TRAP-NEST AND SCIENTIFIC BREEDING

TO THE EDITOR:

Do you have any information on the originator of the trap-nest? Your mention of the installation of 52 trap-nests by G. M. Gowell in 1898 suggests that you may have found mention of the inventor's name in your work in compiling the chronology of genetics in the 1937 U.S.D.A. Year Book. The inventor of the trap-nest—who ever he may be—placed an important and very valuable piece of apparatus at the disposal of those who came later to study the inheritance of egg production. I for one should like to know who he was. So if you have any information on this point I shall be much obliged if you will pass it along.

While on the subject of breeding, I should like to have your views on the use of the word scientific associated with breeding. When is breeding scientific and when is it not scientific? Probably there is no sharp line of distinction. Nevertheless, Gowell, as Pearl showed, was employing wrong methods which accounts for his failure in increasing the average annual production of his birds.

This being the case does the use of trap-nests entitle his work to be called scientific seeing that other methods of obtaining a record on the number of eggs laid by a hen have been used? I have seen accounts of some of these other methods which were said to have been used in America prior to the use of the trap-nests. I do not know when the practice of penning birds individually was first introduced, but the Australian egg laying contests followed this practice for many years after the use of trap-nests in this country was a well established practice.

I do not want to belittle Gowell's work. He was one of the pioneers in his field and along with Charles D. Woods, deserves much credit for making an attempt to improve the productive ability of hens. The use of the trap-nest marks a distinct improvement in method. Nevertheless, if his work in breeding is correctly described by scientific, I suspect that the work of some of his predecessors should fall in the same category.

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Professor Gowell's experiments were the first record found of the use of the trap-nest in poultry breeding, but he appears not to have been the inventor. The inventor of the trap-nest is not known to the writer, and any information concerning him would be welcomed. The earliest patent issued for a trap-nest for poultry was in 1854, so that it may have been used in poultry breeding before Gowell's time.

The compiler of the Chronology had no intention of passing judgment on the relative "scientificness" or lack of "scien-

tificness" of Gowell's work as compared with that of his predecessors and successors. The choice of words was unfortunate, as the intent was simply to note an advance in method which facilitated the application of scientific selection, without attempting to pass on the validity of Gowell's methods.

As for a definition of "scientific", it is one of those relative terms which vary tremendously with conditions. Thus in the years shortly following the rediscovery of Mendel's work, a "scientific" approach to a breeding problem would seem to include among other things, a survey of all available evidence regarding the mendelian inheritance of the characters in question and the utilization of any of this information which could be applied to the problem under attack. Today a scientific approach to a plant breeding problem would seem to involve in addition a survey of the chromosome situation in the material which it is proposed to use. "Is it a polyploid?" "Does it produce normal pollen?", etc., etc. On the other hand a scientific approach to livestock breeding at the present time would not involve nearly as much preoccupation with the chromosomes, because at the moment we do not know enough about mammalian chromosomes to make our knowledge of much practical use in a breeding program. "Scientific" in the sense of Professor Goodale's query would seem to imply the use of all demonstrated facts to gain our ends rather than depending merely on hope, luck, or magic. In the case of Gowell's trap-nesting experiment he may have proceeded "scientifically" in the light of knowledge of that time, even though more knowledge might have proved his failure to be due to the fundamental "unscientificness" of his methods. The most advanced methods in use today may appear little better than rank superstition to breeders a century hence.

A goodly supply of reprints of the chronology of genetics to which Dr. Goodale refers has been promised by the Editors of the *Yearbook*. In order that this effort may be of greatest usefulness as a groundwork for a really adequate historical treatment of the scientific study of heredity, we will consider it a privilege to record in a "Chronology Column" in the JOURNAL any criticisms that will contribute to this most interesting subject. As long as these are available, copies of the reprints will gladly be furnished to members of the A. G. A.

The *Yearbooks* for 1936 and 1937 constitute a remarkable résumé of genetic knowledge and its application to breeding problems. An extended review of the two volumes is planned in an early issue of the JOURNAL. Copies of the yearbooks can be obtained from congressmen, by their constituents, or they may be purchased from the Superintendent of Documents, Washington—at $1.25 for the 1936 volume and $2.00 for the volume just issued.—ED.

To the above Dr. Goodale replied:

I am much obliged for your letter of September 23rd, which answers fully my inquiry regarding the use of the word "scientific" in the chronology.

It may very well turn out that your course in preparing the chronology was a very fortunate one for it furnishes a very useful and valuable body of information, even if not in the shape you could wish. I can understand that being obliged to rush the thing through is not satisfactory to the author. Nevertheless opportunity must be seized when presented and yearbooks like trains must be taken at their convenience.

The number of different designs of trap-nests that are, or have been in use suggests that it is fairly easy to build a successful nest. So perhaps the real question is, who first conceived the idea of building such a nest and who first put it in use? It may be that Gowell was the first man to put the idea into constructive use even if he did not invent the first trap-nest.

Many designs for trap-nests were never patented, and so the records of the Patent Office might not solve the question though they may furnish a clue. A man in Maine used to advertise a design which was very clever. This was not many years after the Maine Station began work. His name was Wishwell (Wis well?) or he lived in Wishwell, I cannot recall which.

In answer to a letter on this subject, Professor James E. Rice of Cornell wrote me that he designed a trap-nest in the nineties which was built under his direction. However, it is not certain that this is the first instance of its kind. H. D. GOODALE

THE SWEET POTATO BROUGHT INTO FLOWER IN LOUISIANA

Figure 8

In the Continental United States the sweet potato rarely flowers under ordinary conditions. This has made the production of improved varieties by breeding methods an impossibility, and has limited improvement in this crop to the discovery of occasional bud mutations. The development of a method of inducing sweet potatoes to produce an abundance of flowers marks a most promising advance because it makes available another species for the practice of the plant breeder's art. The procedure described in the accompanying article, should make it possible to conduct sweet potato breeding experiments in many of the Southern states.

INDUCING THE SWEET POTATO TO BLOOM AND SET SEED

JULIAN C. MILLER

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THE fact that the sweet potato rarely has produced flowers and true seed in the Continental United States has placed the various investigators, particularly those of the State experiment stations, in a rather helpless position in regard to any improvement program other than the selection of new types which arise as mutations and which must be propagated asexually. Since but few factors are under control, this type of asexual selection naturally has its limitations. Many workers have realized that if the sweet potato plant could be induced to flower and set seed, a breeding program could be set up, with a definite purpose such as breeding for disease resistance, yield, table and keeping quality, shape, or for high sugar or starch content.

During the summer of 1936, a number of treatments such as root pruning, vine girdling, growing the vines on a trellis, photoperiod regulations, and simulation of natural flowering and fruiting conditions, were tested with some of the leading American varieties for the purpose of inducing flower and seed production.

Method Employed

The treatment that induced the plants to bloom and set seed was that which simulated conditions under which natural flowering occurs. This procedure consisted of the following steps: The plants were set to the greenhouse in August, 1936. As soon as the vines began to grow, they were trained to a trellis made of telephone wire to allow the vines more air and light. The plants were kept growing under as near optimum conditions as possible until November 20. At that time, no flowering had occurred on the greenhouse plants. It was then decided to give these plants a special treatment which was as follows: Since phosphate is considered conducive to seed setting, two pounds of superphosphate was worked into the soil around each plant in an area approximately 4 feet square. The soil about the plants was then watered heavily and kept on what might be considered the wet side of optimum from November 20 until January 1. During this period, the plants developed a highly vegetative growth. Beginning January 1 and extending to February 15, the plants were watered very lightly, or kept on the dry side for optimum growth. During this time, many of the lower leaves of the plants died off and the vine and upper leaves took on a yellowish-green cast, which usually indicates the building up of a high carbohydrate reserve.

Following this period of drying or desiccation, the plants were again watered heavily for six weeks until they again became rather vegetative. Following this, the plants were watered so as to maintain optimum growth. In the latter part of this second vegetative period, about April 10, the plants bloomed and set true seed from selfed, crossed, reciprocal crossed, and inter-crossed flowers from four varieties; namely, Unit No. 1 Porto Rico, Porto Rubio, U. S. Seedling B-52, and U. S. Seedling 291. A total of 64 seed was harvested from the four plants.

Other factors to which the potato plants were subject during the period of blossoming and which must have had a contributing influence upon the flowering and setting of seed were: a day length of 11½ hours, which increased during the period of blossoming to 12½ hours; a relative humidity of 75 to 85 per cent; and a temperature varying from 70 to 80 degrees F.

So far as it has been determined, this

DETAILS OF SWEET POTATO FLOWERS

Figure 9

Flowers, seeds, and tubers of the sweet potato. The sweet potato flower is two-celled like most morning glories, and ordinarily four seeds are produced. As yet some of the most useful varieties have been brought into flower too late to set seed, but it is believed that modifications of the new method will make available all forms of this species for use by the breeder.

is the first time that definite controlled crosses with the sweet potato have been made in the Continental United States.

As soon as the last seeds on the plants were mature, all seeds were planted in sterilized soil in 3-inch pots, with a single seed to a pot. During the first 48 hours following the planting, 50 per cent of the seed germinated. Some of the seed, according to Thompson[6], will germinate over a period of 100 days. A similar type of germination was obtained from a lot of seed received from the Cuban Agricultural Experiment Station.

These studies indicate that in order for the sweet potato plant to bloom and set seed, the plant must be old enough to have built up carbohydrate reserves in the vines. The plants have bloomed most freely with a day length of 11½ hours and have set seed best with an increasing day length from 11½ to 12½ hours. With a decreasing photoperiod such as we have in the fall, from 11½ hours to about 10 hours, the plants of Porto Rubio, and U. S. Seedlings B-52, 291, 029879, and 029942, have blossomed profusely in the field but none has set seed so far. The plants also blossom better when the vines have been trained to a trellis and each vine given plenty of air and light. It is further noted that each variety or group has its own exacting conditions under which it flowers and sets seed. With some of the leading American varieties, such as the Porto Rico, it has been difficult to obtain flowers and seed even in the insular possessions of the United States, such as the Virgin Islands and Puerto Rico, and in neighboring areas such as Cuba and Jamaica; therefore, if methods can be worked out by which these American varieties can be induced to set seed in the Continental United States, it will be of material benefit.

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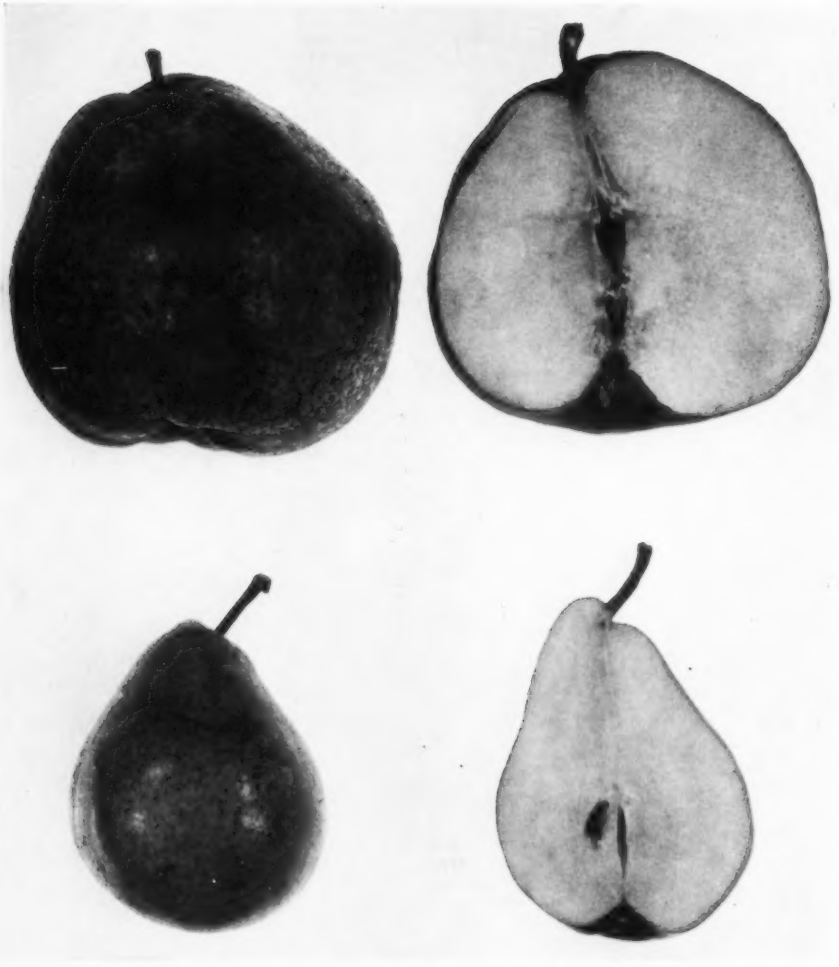
The John Anisfield Awards

The John Anisfield Award of $1,000 was established in 1934 by Mrs. Edith Wolf, Cleveland, in memory of her father, John Anisfield, to encourage the production of good books in the field of race relations published either in the United States or abroad. A grant-in-aid of $500 also has been provided for assistance in the completion of a study of race relations during 1938. The committee of judges consists of Henry Pratt Fairchild, New York University; Donald Young, Social Science Research Council; and Henry Seidel Canby, *Saturday Review.*

The $1,000 award is for the most significant book dealing with race relations selected by the judges from publications between August 1, 1936, and December 1, 1937. There have been two awards to date: in 1935, to Harold F. Gosnell for his book *Negro Politicians;* in 1936, to Julian Huxley and A. C. Haddon for their book *We Europeans: A Survey of "Racial" Problems.*

The $500 grant-in-aid is available for a project either of an academic nature or of the outgrowth of practical experience in the field of race relations. Only proposals on which appreciable progress already has been made will be considered.

All communications should be addressed to Donald Young, Social Science Research Council, 230 Park Avenue, New York. Three copies of each book proposed for the main award should be sent to him as soon as possible after publication, and in no case later than January 15, 1938. The closing date for the receipt of applications for the $500 grant-in-aid for 1938 will be December 1, 1937. The decision of the committee will be announced about February 15, 1938.



A GIANT WINTER NELIS PEAR

Figure 10

A large fruited mutation of the Winter Nelis pear (above), and comparable normal pears of this variety (below). The photograph is over half natural size and shows clearly the differences in size, form, and in other characteristics which differentiate the normal and mutant strains. In some respects the giant form suggests a tetraploid, but microscopical study of the cells shows the number of chromosomes to be the same in both forms.

A LARGE-FRUITED BUD MUTATION OF THE WINTER NELIS PEAR

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WHILE on a trip to Washington apple and pear growing districts during the autumn of 1932 for the purpose of studying bud sports in some of the trees of the commercial varieties of those fruits, the writer had an opportunity to examine the fruit exhibits at the Washington state fair that was being held at Puyallup. He was struck by the large size of the Winter Nelis pears in a plate display. Previously one of the leading Winter Nelis pear growers in the Yakima district had remarked that a strain of this variety that would produce fruits of larger size than the normal ones was greatly to be desired and would be a valuable contribution to commercial pear growing in that district. Subsequently, other pear growers in the Yakima and Wenatchee districts expressed a similar opinion.

This thought was freshly in mind while the writer was viewing the pear exhibits and the plate of large Winter Nelis immediately suggested the possibility that these fruits might be of the large-fruited strain desired by some growers. Through John T. Bregger, then Extension Horticulturist of Washington State College, it was learned that the grower of the exhibit was Edward Veckman. The Winter Nelis pear tree which had borne the large-sized fruits was located in Mr. Veckman's home garden. He reported that this tree had consistently borne large-sized fruits but there was no definite evidence available that it was of an inherently large-fruited strain, as the history of the tree was unknown. The question arose as to whether it was an inherently large-fruited strain, or merely produced the large-sized fruits as a result of local environmental influences. Accordingly, it was decided to determine the facts through a progeny propagation test of the tree.

In April, 1933, buds were obtained from the large-fruited Winter Nelis tree and topworked on a young Bartlett pear tree at the U.S.D.A. Field Station at Shafter, California. Two of the inserted buds grew while the other two failed to grow so that the tree top developed into a limb structure made up of two limbs from the inserted buds and two from the Bartlett buds. Eventually the growth from the Bartlett buds will be cut out leaving only that from the buds taken from the large-fruited Winter Nelis tree.

There were 21 fruits borne by the progeny tree in 1935 having a total weight of 12.1 pounds, or an average weight of 9.2 oz. per fruit. A representative sample of ordinary Winter Nelis fruits from comparable trees weighed 4.5 oz. per fruit or about one-half that of the large-sized pears. The measurements of the longitudinal and transverse diameters of representative samples of large-sized and normal fruits in this test are shown in the following table.

A typical large-sized fruit had a transverse diameter of 85 mm. while a comparative normal one had a diameter of 58 mm. Two such fruits are shown in the accompanying illustration. The fruits of the tree of the large-sized strain were quite similar in outward appearance to the normal ones. The typical large fruit had a somewhat larger and more open core than the normal one, and 10 seeds that appeared to be a little smaller than the six normal seeds. The flesh of the large fruit was slightly less buttery than that of the normal fruit, but with the same flavor and taste and with a slightly firmer texture. The color of the flesh was the same in both specimens, and the differ-

ences in texture seem too slight to be of commercial significance.

During the 1936 season the two limbs of the large-fruited Winter Nelis strain in the topworked trees produced a total of about 50 fruits. These showed the same characteristic size, shape, color and texture, and earliness of maturity as those of the preceding crop. There was no doubt in the minds of observers that the large fruited pears were inherently of large size and that this and other characteristics of these fruits had been transmitted by bud propagation.

Comparative tests of ripe pears of the two strains have been made recently by George A. Harrison, Superintendent of the Shafter Station. He reports, "On November 19, 1935, there was a distinct sweetness in flavor of the large-fruited pears. There was also more juice in the large fruits than in the normal ones but their texture was slightly coarser and they seemed to be in a more advanced stage of maturity. Since harvesting, the fruits in storage of the two strains have been sampled. My observations of these are that the large sized pears are much sweeter, much more juicy, slightly coarser in texture, more distinctive in flavor, tend to ripen faster in storage and will not likely keep quite as well in storage as the normal pears. Both lots seem to have similar tendencies to shrivel slightly in storage. The several persons here who have sampled these fruits agree with me as to the relative sweetness, juiciness, texture and flavor of the two lots of fruit."

The characteristics of the foliage of the normal Winter Nelis tree and that of the large fruited strain appeared to be identical.

There were some indications that the large-fruited Winter Nelis strain might be a tetraploid bud mutation, but cytological studies of the flower buds by Dr. J. L. Cartledge of West Virginia University has shown that the pollen mother cells have the normal number of chromosomes, that is 17 haploid and 34 diploid, and that the mutation is probably not a tetraploid.* A somewhat analogous large-fruited Bartlett pear bud mutation at the Shafter Station has been studied along the same lines and the cytological studies of the flower buds of this strain were made under the direction of Dr. A. F. Blakeslee, of the Department of Genetics, Carnegie Institution of Washington, at Cold Spring Harbor, New York. The normal Bartlett trees in the Shafter orchard were found to have, as expected, 17 haploid chromosomes while the large-fruited Bartlett strain had either 34, or one more or less.†

While the parent large-fruited Winter Nelis tree at Puyallup, Wash., may be of seedling origin, it seems more probable to the writer that it originated as a bud sport. This opinion is based upon his observations of similar large-fruited bud mutations in the Bartlett pear and in the trees of other fruit varieties that have been studied from time to time during recent years. It is too early as yet to evaluate the commercial possibilities of this large-fruited Winter Nelis pear strain.

TABLE I. Measurements of length and thickness, in millimeters, of 6 large sized and 6 normal sized Winter Nelis pears grown at Shafter, California, November 19, 1935

Large Sized Winter Nelis		Normal Winter Nelis	
Length	Thickness	Length	Thickness
72	86	53	53
76	82	58	55
79	81	61	56
78	68 (deformed)	58	54
74	77	60	58
76	80	65	60
Ave. 75.0	79.0	59.16	56.0

*Letter dated Sept. 25, 1937, from Dr. J. L. Cartledge, West Virginia University, Morgantown, West Virginia.

†Letter of June 11, 1936, from Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor, Long Island, New York, signed, J. L. Cartledge.

A HEREDITARY EYE DEFECT IN GUINEA PIGS

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EYE defects differing in character and degree have been reported by various authors in fishes, birds, and mammals including man. These defects range from those so slight that vision is not impaired to others so severe that vision is seriously affected or entirely lacking. In some of these, associated structural anomalies occur which prevent the survival of the organism. Cyclopia and its associated head abnormalities are examples of the latter condition. Other less serious defects include anophthalmia (absence of eyeballs), microphthalmia (small eyeballs), opaque lens, and several others. Some eye defects are very rare and appear to be mere chance occurrences, induced perhaps by some unfavorable environmental condition at a critical period during embryonic development when the eye anlage are being formed. Other eye defects are hereditary, although the mode of inheritance of many such defects is difficult to determine since a given defect may show much variability in degree of expression or actually may not appear at all in a genotypically defective animal. The likeness of many experimentally induced and hereditary eye defects suggests a similarity in the physiological causes producing them, whether they occur by chance or whether they are hereditary.

Genetics of Eye Defects

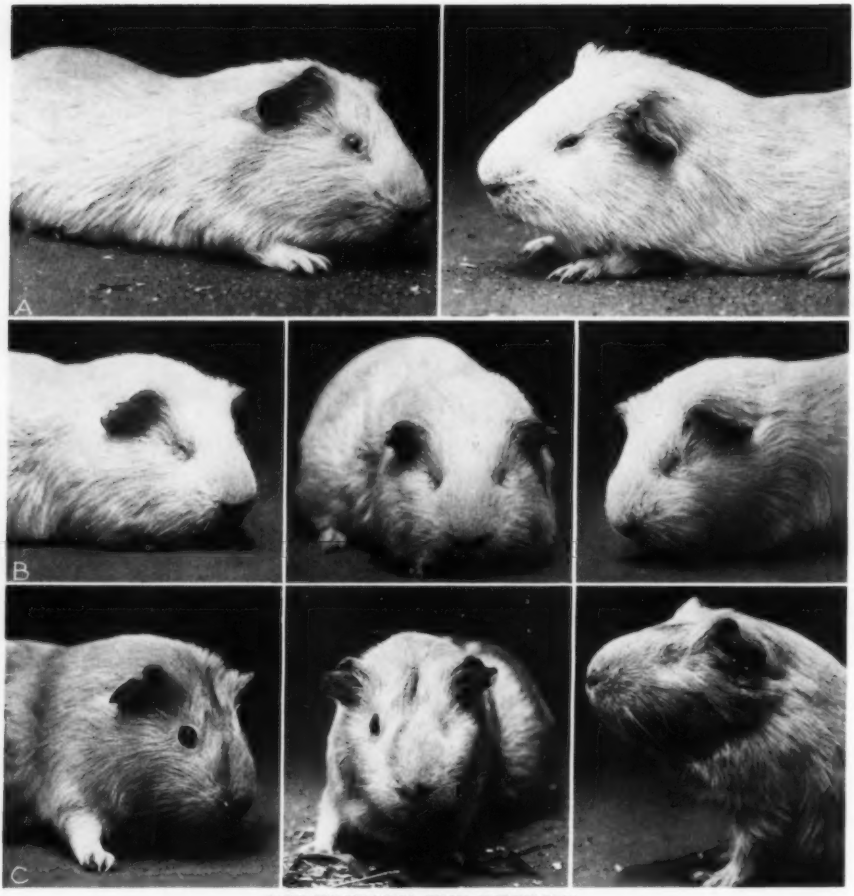
The eye defect reported in this paper includes several conditions apparently closely related as to origin, namely, anophthalmia, microphthalmia, opaque lens, and rotated eyeball, so that the cornea and parts visible behind it are nearly or completely out of sight (Figure 11).

Apparently the first investigations of similar eye defects were the experiments of Guyer[3] and Guyer and Smith[4-6] with rabbits, between 1918 and 1925. By injections of fowl serum sensitized to rabbit lens, the authors reported eye defects in the offspring of the type described above. These experiments caused considerable comment and controversy but attempts by various investigators, among them Huxley and Carr-Saunders[9] and Ibsen and Bushnell,[10-12] to verify the work of Guyer met with little success.

In other species various authors have described similar defects. Pearson[15] reported the natural occurrence of a similar eye defect in about 1.5 per cent of a strain of white mice, and Jones,[13] Detlefsen[2] and King[14] reported it in white rats. Hain[7] has recently reported on the occurrence of eye defects through 14 generations of rats obtained originally from the Wistar strain in which King reported eye defects. His results differ from those of King, mainly in the effect of the defect upon vitality and fertility. King found these factors below normal in affected rats, while Hain reports that they were unaffected except for a tendency to sterility in the female.

Hale[8] reported a litter of 11 Duroc-Jersey pigs all without eyeballs, but attributed it to deficiency of vitamin A, since the dam of the defective-eyed litter was on a vitamin A-deficient diet, and only normal young were produced by the same boar when mated with 2 other sows.

The defect reported in this paper occurred in the stock of guinea pigs maintained by the Bureau of Animal Industry for genetic experiments. It occurred in a homozygous pink-eyed (pp) stock known as the L strain. No particular system of mating had been adhered to in this strain, but it was considerably inbred. The defect was first observed



HEREDITARY EYE DEFECTS

Figure 11

A—Male *B*. From mating L-214 (see pedigree chart, Figure 12). He was used in matings L 231, 232, E-13, 15, 17. The right eyeball is rotated; the left eye is dwarfed (microphalmic). *B*—Female 49038. She is from mating E-6, and was used in matings E-9 and 11. She is totally eyeless. *C*—Female 50669, with normal right eye and no eye on the left. She is from mating L-237, and was used in mating E-16. In this pedigree, eyelessness on one or both sides, rotation of the eye, and pathologically small eyeballs, apparently have a close genetic relationship.

in the descendants of a single mating, *L*-205, and 26.1 per cent of the young through 5 generations were affected. In several other inbred and crossbred stocks maintained in this colony the frequency of similar eye defects is 35 per 10,000, and these do not appear to be inherited. The first defective-eyed individuals appeared in mating *L*-213 (see pedigree chart). This mating produced 33 young, of which 8 were eyeless, 1 had no eyeball in the left side and the right eye was defective, 6 had microphthalmic or opaque eyes, 17 were normal, and 1 undetermined. A sister of the sire and dam of the above offspring produced 15 progeny (*L*-214), of which 1 had defective eyes, 10 were normal, and 4

undetermined. Two other sisters from a later litter were mated with a male from *L*-193 which was very remotely related. One of these matings (*L*-219) produced 19 normal young, and the other (*L*-220) 3 young, 1 of which had a defective left eye. The defective-eyed male from mating *L*-214 was mated with 2 defective-eyed females from *L*-213, making matings *L*-231 and *L*-232. The former produced 2 young, an eyeless male and a normal female. Mating *L*-232 produced 13 young, including 10 normal, 1 with a defective left eye, and 2 undetermined. Two defective-eyed young from *L*-213 produced mating *L*-230, which produced 4 normals, 7 with both eyes defective, 2 with a defective left eye, and 1 eyeless. Another defective-eyed male from *L*-213 was mated with a normal sister (mating *L*-234) and produced 6 normal, 2 eyeless, 1 with the left eye absent and the right eye defective, 1 with the left eye defective and the right eye absent, 1 with a defective left eye and the right eye normal, and 3 undetermined. A normal pair from *L*-219 (mating *L*-237) produced 20 offspring, including 14 normal, 1 defective in both eyes, 2 with a defective left eye and the right eye absent, 2 with left eye defective and the right eye normal, and 1 with the left eye absent and the right eye normal. In mating *L*-213 practically one-half the young were affected, and in the following generation three-fourths of the young in mating *L*-230 and two-fifths of those in mating *L*-234 were affected. In the following 2 generations and back-crosses, 22 matings produced only 30 young, all of which were normal except 1 eyeless female and 1 with defective left eye. Fourteen of these 22 matings produced no young. In five of the fourteen the male or female died before they were old enough to reproduce (see Figure 12).

Analysis of this pedigree suggests that either the stock carried the necessary factors for this defect for several generations previous to its appearance in the few matings here described, or a mutation occurred in mating *L*-205 which gave rise to the immediate ancestors of the defective young. The first hypothesis is strengthened by the fact that the male from *L*-193 used in matings *L*-219 and *L*-220 apparently carried the defect. The second hypothesis seems reasonable because all the defective young are concentrated among the offspring of four females from *L*-205.

Mortality in the pedigree here concerned was higher than in the other guinea pig stocks during the same period (1930-1934). Among 6,754 young produced in the other stocks, 17.9 per cent were dead at birth, 20.3 per cent died between birth and weaning, and 61.8 per cent were raised to weaning (33 days). In the defective stock 21.1 per cent were born dead, 21.1 per cent died between birth and weaning, and 57.8 per

TABLE I (a). Mortality in defective-eyed guinea pigs compared with normal stocks (1930-1934).

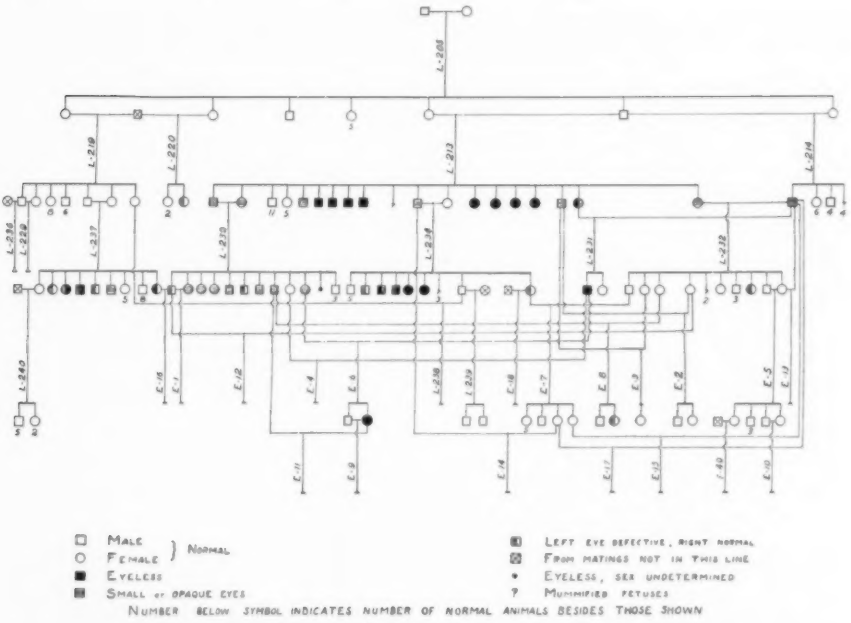
Stock	Number Animals	Born Dead	Died Between Birth and Weaning	Raised to Weaning
		Per cent	Per cent	Per cent
Defective-eyed strain	175	21.1	21.1	57.8
Normals from defective-eyed strain	132*	20.4	16.7	62.9
Defectives from defective-eyed strain	43	23.3	34.9	41.8
All other strains	6,754	17.9	20.3	61.8

*Ten unclassified young are included in this group. They were mummified, and composed 5.71 per cent of the defective-eyed strain. In all other strains, 1.45 per cent of mummified fetuses occurred.

(b). Mortality by Generations.*

Generation	Number Animals	Born Dead	Died Between Birth and Weaning	Raised to Weaning
		Per cent	Per cent	Per cent
F_1 from *L*-205	11	....	....	100.0
F_2	70	14.3	22.8	62.9
F_3	64	29.7	21.9	48.4
F_4	18	16.7	22.2	61.1
Backcross (normal × defective)	3	66.7	33.3	0.0

*Two matings (*L*-239 and *L*-240) were outcrosses and are not included in this table. They produced 9 young, of which 3 were born dead, 2 died before weaning, and 4 were raised to weaning.



A PEDIGREE-CHART OF EYE DEFECTS IN GUINEA PIGS

Figure 12

While the incidence of eyelessness in this pedigree leaves little doubt that genetic factors are involved, the exact mode of inheritance is not clear. Note that in some instances inbred matings between normal eyed individuals have produced large numbers of affected offspring, while in other cases inbred matings between affected individuals have produced a majority of normal offspring. Environmental influences at a critical stage probably determine the developmental history of the eyes.

cent were raised to weaning in a total of 175 young produced in this stock. Mortality was higher among the defectives than among the normals in the defective stock. Among the normals 20.4 per cent were born dead, 16.7 per cent died between birth and weaning, and 62.9 per cent were raised to weaning, compared to 23.3 per cent born dead, 34.9 per cent which died between birth and weaning, and 41.8 per cent raised of the defective individuals. The percentage of decomposed and mummified fetuses was considerably higher among the defective-eyed stock than for all other stocks, being 5.71 per cent for the former and 1.45 for the latter (see Table I).

The average number of young per litter was the same for the defective-eyed line as for all other stocks combined during the same period, viz. 2.57.

The sex ratio was normal in the defective-eyed stock, being 61 males : 59 females in those which were normal, and 21 males : 21 females among the defective young.

The total number of descendants of mating *L*-205 was 175. Of these, 10 were mummified or decomposed so that the sex or the condition of the eyes could not be determined. The 11 young produced in mating *L*-205 were normal. If a mutation is considered as having taken place in mating *L*-205, then the young produced by this mating may be considered as the F_1, leaving 154 classified young in the F_2 and following generations.

The matings were classified as to type of the sire and dam, three types being

recognized, normal, defective and eyeless. In matings of normal to normal and normal to defective the classes of normal, defective, and eyeless young do not depart significantly, according to the χ^2 (chi-square) test, from a 12:3:1 ratio (Table II). No young were produced by matings of normal to eyeless. Matings of defective to defective should produce only defectives and eyeless in the ratio of 14:2 respectively, assuming a two-factor hypothesis in which *aaB-* may be considered defectives and *aabb* eyeless, which is suggested by the 12:3:1 ratio. However, more than half the progeny from such crosses were normal. Matings of defective to eyeless produced but two young, one normal and one eyeless. Theoretically, there should be no normals, but two defectives to one eyeless. No matings were made of eyeless to eyeless, since only two such animals survived to mating age. The male produced in mating *L*-231 was the sire of the female produced in mating *E*-6. This male died soon after the birth of the litter and the young female was mated with her normal brother. (See Pedigree Chart.) The class distribution for the total population excluding the F_1 animals is very close to a 12:3:1 ratio, with departure from expectation not significant.

Discussion

The foregoing data show that the eye defect described is hereditary, but the exact mode of inheritance cannot be definitely determined from the data available. Hain[7] suggests that in rats a dominant factor is concerned, but these data do not suggest that the defect is dominant, except possibly the results from matings *L*-230 and *L*-234. King[14] does not consider the eyeless condition hereditary in rats, but its frequency in the guinea pig matings discussed practically excludes its appearance as due merely to chance. The two-factor hypothesis suggested by the ratios of normal and defective progeny from the different classes of matings is not satisfactory for several reasons. (1) The classification may be inaccurate, since individuals occur that have only one eye affected, or in which the two eyes may be affected differently. (2) The exact type of mating is likewise subject to error for the same reason. Similar phenotypes may be quite different genetically. (3) The high percentage of mummified fetuses may affect the observations by suppressing the appearance of certain types, or they may be a distinct genetic type themselves. (4) The production of normals when defective by defective and defective by eyeless are mated is not in keeping with a two-factor hypothesis.

The low vitality found agrees with the observations of King[14] and Hale[8]. The percentage of defectives did not increase with succeeding generations as with King's rats, but the percentage of mortality increased considerably in the F_3 generation. The possibility of lethal action is supported by the fact that only 8 of 13 eyeless young were born alive, and that of these but 3 survived to weaning. One-half of the other defectives were born dead or died before weaning. Bagg and Little[1] reported that 20 per cent of abnormal-eyed young from X-rayed mice died in early stages of development. The lower mortality in the F_4 generation of

TABLE II. Classes of young produced by different types of matings. (Expectation for 12:3:1 ratio in which it is assumed that defective-eyed animals are *aaB-* and eyeless are *aabb*.)

Type of Mating	Classes of Progeny				X^2
	Normal	Defective	Eyeless	Total	(chi-square)
Normal × Normal	77	15	8	100	
(Expectation)	(75)	(19)	(6)	(100)	1.562
Normal × Defective	18	5	2	25	
(Expectation)	(19)	(5)	(2)	(26)	.053
Defective × Defective	15	10	2	27	
(Expectation)		(25)	(2)	(27)	
Defective × Eyeless	1		1	2	
(Expectation)		(2)	(1)	(3)	
Total (excluding F_1 from mating *L*-205)	111	30	13	154	
(Expectation)	(115)	(29)	(10)	(154)	1.074

this experiment is probably explained by fewer matings between affected individuals. A higher percentage of sterility was noted in the F_4 generation but the reasons for it are not apparent.

There was a tendency for the left eye to be affected more often than the right. In the 10 cases where only one eye was affected, all were on the left side. Both eyes were affected three times as frequently as one eye.

As in the case just described, an understanding of the causes responsible for many of the anomalies occurring in animals is not clear from the data available, but investigations of a cytological and physiological nature with lower forms (Insecta and Amphibia) aid in explaining their causes. Many of the abnormalities found in Drosophila have been shown to be the result of various chromosomal abnormalities, such as deletions, translocations, and others. Similar phenomena may occur in the chromosomes of higher organisms. The presence of modifying genes which affect the rate of development of parts may also be advanced as a possible explanation of the varying degrees of abnormality. Apparently the several eye abnormalities observed are various degrees of a single defect. Threshold effects may account for this. Thus, at a given level of physiological activity, normal individuals may be produced. At a certain point below this level normal development is interfered with and slight degrees of abnormality may result. At still lower levels of physiological activity more serious interference with development takes place and more serious defects may occur.

Another possibility is that certain genes must produce their effect at a certain critical period of development. If something interferes at this particular time, nothing takes place, and if the genes concerned are ones to produce abnormal development, a normal animal results. It is equally true that the reverse of this condition might take place. It seems obvious that the most serious conditions, such as absence of eye-balls, are caused by the necessary forces acting at an earlier period of embryonic development than those which produce less serious abnormalities. At any rate, there must be a close interaction between genetic and physiological forces during the developmental period.

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